COURSE OVERVIEW RE0140-4D

Machinery Failure Analysis, Prevention & Troubleshooting

Machinery Diagnostics and Root Cause Failure Analysis (RCFA)

Course Title

Machinery Failure Analysis, Prevention & Troubleshooting: *Machinery Diagnostics and Root Cause Failure Analysis (RCFA)*

Course Reference

RE0140-4D

Course Duration/Credits

Four days/2.4 CEUs/24 PDHs

Course Date/Venue

Session(s)	Date	Venue
1	September 09-12, 2024	Fujairah Meeting Room, Grand Millennium Al Wahda Hotel, Abu Dhabi, UAE
2	December 16-19, 2024	Boardroom, Warwick Hotel Doha, Doha, Qatar

Course Description

This practical and highly-interactive course includes various practical sessions and exercises. Theory learnt will be applied using our state-of-the-art simulators.

The course presents a systematic approach to fault diagnosis and failure prevention in a broad range of machinery used in the Oil/Gas, Petrochemical and other process industries. The key approaches to preventive maintenance are demonstrated through both overview and the study of examples in metallurgical failure analysis, vibration analysis and a sequential approach to machinery troubleshooting and problem solving.

Equipment failure events will be reviewed and participants are encouraged to bring to the course relevant assembly drawings or such components as failed bearings, gears, mechanical seals and similar machine elements for failure analysis and discussion.

The course explores a systematic approach to successful failure analysis and troubleshooting, including the determination of goals, use of checklists and setting up a failure analysis team.

By reference to specific case studies, especially dealing with centrifugal pumps, it will be shown that such a systematic program can lead to significant failure reductions in many types of machinery.

Through examples dealing with pumps and compressors, guidance is given on vendor selection and methods for reliability review.

A matrix approach to machinery troubleshooting uses illustrative examples in pumps, centrifugal compressors, blowers and fans, reciprocating compressors, engines and gas turbines. Next, a systematic approach to generalized machinery problem-solving is described in terms of situation analysis, cause analysis, action generation, decision making and planning for change. Finally, a highly effective root cause failure analysis (RCFA) method is explained in detail.

At the end of the course, participants will gain an understanding of structured, results-oriented root cause failure analysis methods for all types of machine components and entire machinery systems. Participants will also learn how parts fail, why they fail in a given mode and how to prevent failures. Participants will acquire a thorough understanding of making the best possible use of available failure statistics and how these can be used in a conscientiously applied comprehensive program of specifying, purchasing, installing, commissioning and operating machinery.

Course Objectives

Upon the successful completion of this course, each participant will be able to: -

- Execute system approach of failure analysis and troubleshooting and identify the causes of machinery failure and their contributing factors which are often overlooked
- Gain an in-depth knowledge on metallurgical failure analysis methodology as illustrated by failure analysis of bolted joints and shafts
- Perform machinery component analysis and reliability improvement by recognizing redesigned opportunities, bearings in distress, coupling failure avoidance opportunities and mechanical seal problems
- Develop an understanding of continuous reliability improvement and the various approaches to optimized lubrication for pumps and electric motors
- Apply and gain an understanding on vendor selection and reliability review methods through centrifugal pump selection & compressor reliability review examples and perform troubleshooting of pumps and centrifugal compressors
- Recognize the application of vibration analysis from a management perspective by studying specific machinery problems, as well as monitoring and analysis methods
- Identify and carryout a structured problem-solving sequence after careful perusal of problem-solving elements, cause analysis, action generation, decision making and planning for change
- Perform formalized failure reporting using actual cases such as high-speed pump and bearing failures
- Determine the process of examination of failed components such as bearings, gears, mechanical seals and others
- List the elements of centrifugal pump failure reduction programs taking into account the process and the mechanical & technical interactions

Exclusive Smart Training Kit - H-STK®

*Participants of this course will receive the exclusive "Haward Smart Training Kit" (**H-STK®**). The **H-STK®** consists of a comprehensive set of technical content which includes **electronic version** of the course materials, sample video clips of the instructor's actual lectures & practical sessions during the course conveniently saved in a **Tablet PC**.*

Who Should Attend

This course covers systematic techniques and methodologies in machinery failure analysis, prevention and troubleshooting for those who work with mechanical and rotating equipment at industrial plants, utilities, production oil/gas field or manufacturing facilities. General maintenance personnel, engineers and other technical staff from a wide variety of industries, skill-levels, company sizes and job titles will also find this course extremely useful.

Training Methodology

All our Courses are including **Hands-on Practical Sessions** using equipment, State-of-the-Art Simulators, Drawings, Case Studies, Videos and Exercises. The courses include the following training methodologies as a percentage of the total tuition hours:-

30% Lectures
20% Practical Workshops & Work Presentations
30% Hands-on Practical Exercises & Case Studies
20% Simulators (Hardware & Software) & Videos

In an unlikely event, the course instructor may modify the above training methodology before or during the course for technical reasons.

Course Fee

Abu Dhabi	**US$ 4,500** per Delegate + **VAT**. This rate includes H-STK® (Haward Smart Training Kit), buffet lunch, coffee/tea on arrival, morning & afternoon of each day.
Doha	**US$ 5,000** per Delegate. This rate includes H-STK® (Haward Smart Training Kit), buffet lunch, coffee/tea on arrival, morning & afternoon of each day.

Accommodation

Accommodation is not included in the course fees. However, any accommodation required can be arranged at the time of booking.

Course Certificate(s)
Internationally recognized certificates will be issued to all participants of the course.

Certificate Accreditations
Certificates are accredited by the following international accreditation organizations: -

- The International Accreditors for Continuing Education and Training (IACET - USA)

  Haward Technology is an Authorized Training Provider by the International Accreditors for Continuing Education and Training (IACET), 2201 Cooperative Way, Suite 600, Herndon, VA 20171, USA. In obtaining this authority, Haward Technology has demonstrated that it complies with the **ANSI/IACET 2018-1 Standard** which is widely recognized as the standard of good practice internationally. As a result of our Authorized Provider membership status, Haward Technology is authorized to offer IACET CEUs for its programs that qualify under the **ANSI/IACET 2018-1 Standard**.

  Haward Technology's courses meet the professional certification and continuing education requirements for participants seeking **Continuing Education Units** (CEUs) in accordance with the rules & regulations of the International Accreditors for Continuing Education & Training (IACET). IACET is an international authority that evaluates programs according to strict, research-based criteria and guidelines. The CEU is an internationally accepted uniform unit of measurement in qualified courses of continuing education.

  Haward Technology Middle East will award **2.4 CEUs** (Continuing Education Units) or **24 PDHs** (Professional Development Hours) for participants who completed the total tuition hours of this program. One CEU is equivalent to ten Professional Development Hours (PDHs) or ten contact hours of the participation in and completion of Haward Technology programs. A permanent record of a participant's involvement and awarding of CEU will be maintained by Haward Technology. Haward Technology will provide a copy of the participant's CEU and PDH Transcript of Records upon request.

- British Accreditation Council (BAC)

  Haward Technology is accredited by the **British Accreditation Council** for **Independent Further and Higher Education** as an **International Centre**. BAC is the British accrediting body responsible for setting standards within independent further and higher education sector in the UK and overseas. As a BAC-accredited international centre, Haward Technology meets all of the international higher education criteria and standards set by BAC.

Course Instructor(s)

This course will be conducted by the following instructor(s). However, we have the right to change the course instructor(s) prior to the course date and inform participants accordingly:

Mr. Manuel Dalas MSc, BSc, is a **Senior Mechanical & Maintenance Engineer** with over **20 years** of industrial experience in **Oil**, **Gas**, **Refinery**, **Petrochemical**, **Power** and **Nuclear** industries. His wide expertise includes **Fracture Mechanics**, **Turbine, Pump & Fan Balancing**, **Material Cataloguing**, **Maintenance Planning & Scheduling**, Reliability Centered Maintenance (**RCM**), **Reliability Maintenance**, **Condition Based Maintenance & Condition Monitoring**, **Asset & Risk** Management, **Vibration Condition Monitoring & Diagnostics** of Machines, **Vibration & Predictive** Maintenance, Reliability Improvement & Vibration Analysis for Rotating Machinery, Effective Maintenance **Shutdown & Turnaround** Management, **Engineering Codes & Standards**, **Rotating Equipment** Maintenance, **Mechanical** Troubleshooting, **Static Mechanical Equipment** Maintenance, **Machinery** Failure Analysis, **Machinery Diagnostics & Root Cause Failure** Analysis, **Plant Reliability & Maintenance** Strategies, **Boiler** Operation & Water Treatment, **Pumps** Maintenance & Troubleshooting, **Fans**, **Blowers & Compressors**, **Process Control Valves**, Piping Systems & Process Equipment, **Gas Turbines & Compressors** Troubleshooting, Advanced **Valve** Technology, **Pressure Vessel** Design & Analysis, **Steam & Gas Turbine**, **High Pressure Boiler** Operation, **FRP Pipe** Maintenance & Repair, **Centrifugal & Positive Displacement Pump** Technology Troubleshooting & Maintenance, **Rotating Machinery** Best Practices, **PD Compressor & Gas Engine** Operation & Troubleshooting, **Hydraulic Tools & Fitting**, **Mass & Material Balance**, **Water Distribution & Pump Station**, **Tank Farm & Tank Termina**l Safety & Integrity Management, **Process Piping** Design, Construction & **Mechanical Integrity**, **Stack & Noise** Monitoring, **HVAC & Refrigeration** Systems, BPV Code, Section VIII, Division 2, **Facility Planning & Energy** Management, Hoist - Remote & Basic **Rigging & Slinging**, **Mobile Equipment** Operation & Inspection, **Heat Exchanger**, **Safety Relief Valve**, **PRV & POPRV/PORV**, **Bearing & Lubrication**, **Voith Coupling** Overhaul, **Pump & Valve** Technology, **Lubrication** Inspection, **Process Plant** Optimization, Rehabilitation, Revamping & Debottlenecking, Engineering Problem Solving and **Process Plant** Performance & Efficiency. Currently, he is the **Technical Consultant** of the **Association of Local Authorities of Greater Thessaloniki** where he is in charge of the mechanical engineering services for piping, pressure vessels fabrications and ironwork.

During his career life, Mr. Dalas has gained his practical and field experience through his various significant positions and dedication as the **Technical Manager**, **Project Engineer**, **Safety Engineer**, **Deputy Officer**, **Instructor**, **Construction Manager**, **Construction Engineer**, **Consultant Engineer** and **Mechanical Engineer** for numerous multi-billion companies including the **Biological Recycling Unit** and the **Department of Supplies** of **Greece**, **Alpha Bank Group**, **EMKE S.A**, **ASTE LLC** and **Polytechnic College of Evosmos**.

Mr. Dalas has a **Master's** degree in **Energy System** from the **International Hellenic University, School of Science & Technology** and a **Bachelor's** degree in **Mechanical Engineering** from the **Mechanical Engineering Technical University of Greece** along with a **Diploma** in **Management & Production Engineering** from the **Technical University of Crete**. Further, he is a **Certified Internal Verifier/Assessor/Trainer** by the **Institute of Leadership and Management** (**ILM**), a **Certified Project Manager Professional** (**PMI-PMP**), a **Certified Instructor/Trainer**, a **Certified Energy Auditor** for **Buildings**, **Heating & Climate Systems**, a **Member** of the **Hellenic Valuation Institute** and the **Association of Greek Valuers** and a **Licensed Expert Valuer Consultant** of the **Ministry of Development and Competitiveness**. He has further delivered numerous trainings, courses, seminars, conferences and workshops internationally.

Course Program

The following program is planned for this course. However, the course instructor(s) may modify this program before or during the course for technical reasons with no prior notice to participants. Nevertheless, the course objectives will always be met:

Day 1

0730 – 0800	*Registration & Coffee*
0800 – 0815	*Welcome & Introduction*
0815 – 0830	***PRE-TEST***
0830 – 0930	***The Failure Analysis & Troubleshooting System*** *Causes of Machinery Failure ● Contributing Factors Often Overlooked*
0930 – 0945	*Break*
0945 – 1100	***Metallurgical Failure Analysis Methodology*** *Failure Analysis of Bolted Joints ● Shaft Failures &Their Origins ● Ductile vs. Brittle Failures of Shafts ● Stress Raisers in Shafts*
1100 – 1215	***Machinery Component Analysis & Reliability Improvement*** *Redesign Opportunities ● Analyzing Wear Failures ● Bearings in Distress ● Rolling Element Bearing (AFB) & Bearing Failure Analysis ● Journal & Tilt-Thrust Bearings*
1215 – 1230	*Break*
1230 – 1420	***Machinery Component Analysis & Reliability Improvement (cont'd)*** *Gear Failure Analysis ● Coupling Failure Avoidance ● Determining the Cause of Mechanical Seal Distress ● Mechanical Seal Selection Strategies ● O-Ring Failures & Their Causes*
1420 – 1430	***Recap***
1430	*Lunch & End of Day One*

Day 2

0730 – 0930	***Continuous Reliability Improvement*** *Optimized Lubrication for Pumps & Electric Motors ● Economics of Dry Sump Oil Mist Lubrication ● Lubrication Considerations for Pump and Electric Motors ● Major Machinery Lubrication Management*
0930 – 0945	*Break*
0945 – 1100	***Vendor Selection & Reliability Review Methods*** *Centrifugal Pump Selection Examples ● Compressor Reliability Review Examples*
1100 – 1215	***Machinery Troubleshooting*** *The Matrix Approach to Machinery Troubleshooting ● Pumps ● Centrifugal Compressors*
1215 – 1230	*Break*
1230 – 1420	***Machinery Troubleshooting (cont'd)*** *Blowers and Fans ● Reciprocating Compressors ● Engines ● Gas Turbines & Others*
1420 – 1430	***Recap***
1430	*Lunch & End of Day Two*

Day 3

0730 – 0930	***Vibration Analysis - A Management Overview*** *Specific Machinery Problems ● Monitoring & Analysis Methods ● Future Outlook*
0930 – 0945	*Break*
0945 – 1100	***Structured Problem Solving Sequence*** *Review of Structured Problem Solving Elements*
1100 – 1215	***Structured Problem Solving Sequence (cont'd)*** *Cause Analysis, Action Generation, Decision Making and Planning for Change*
1215 – 1230	*Break*
1230 – 1420	***Structured Problem Solving Sequence (cont'd)*** *Root Cause Failure Analysis (RCFA) Principles*
1420 – 1430	***Recap***
1430	*Lunch & End of Day Four*

Day 4

0730 – 0930	***Formalized Failure Reporting as a Teaching Tool*** *Actual Cases Cited and Explained in Detail ● High Speed Pump Failure & Bearing Failures*
0930 – 0945	*Break*
0945 – 1100	***Examination of Failed Components*** *Bearings ● Gears ● Mechanical Seals & Others*
1100 – 1215	***Process/Mechanical/Technical Interaction*** *How PMT Teams Work ● Turnaround Management ● Preventive vs. Predictive Maintenance Concepts*
1215 – 1230	*Break*
1230 – 1345	***Process/Mechanical/Technical Interaction (cont'd)*** *Integrated versus Separate Maintenance ● Centrifugal Pump Failure Reduction Programs*
1345 – 1400	***Course Conclusion*** *Using this Course Overview, the Instructor(s) will Brief Participants about the Course Topics that were Covered During the Course*
1400 – 1415	***POST-TEST***
1415 – 1430	*Presentation of Course Certificates*
1430	*Lunch & End of Course*

Simulator (Hands-on Practical Sessions)

Practical sessions will be organized during the course for delegates to practice the theory learnt. Delegates will be provided with an opportunity to carryout various exercises using the "iLearnVibration" simulator.

iLearnVibration Simulator

Course Coordinator

Mari Nakintu, Tel: +971 2 30 91 714, Email: mari1@haward.org